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Environmental Evidence

SYSTEMATIC MAP

Open Access

What evidence exists on the impact of governance type on the conservation effectiveness of forest protected areas? Knowledge base and evidence gaps

Biljana Macura[1,2*], Laura Secco[1] and Andrew S. Pullin[2]

Abstract

Background: Governance processes and structures that steer social-ecological systems and in situ forest conservation strategies such as protected areas (PAs) can be crucial for effective management and improvement of the conservation outcomes. Nevertheless, knowledge synthesis on how types of local governance and decision-making modes may influence conservation outcomes of forest protected areas is lacking. This is mainly because the evidence on the joint relationships between governance regimes and ecological or social outcomes is generally missing and the knowledge comes from case studies. The research on this topic that use quasi-experimental designs aimed at inferring strong causal relationships is still methodologically in a development phase and the causal effects are hard to isolate. This map describes and maps the available qualitative and quantitative evidence from a large number and variety of sources, both peer-reviewed and grey literature, to answer the following question: What evidence exists on the impact of governance type on the conservation effectiveness of forest protected areas? This across-case systematic map reveals knowledge gaps, methodological limitations of the primary research and generates a list of specific research questions for future research.

Methods: Evidence was collated from multiple sources, academic and grey literature. Using predefined inclusion criteria generated in a published protocol, we identified and screened articles for relevance at title, abstract and full text. Evidence was collated using English language search terms and applying no geographical limitations. Identified studies were critically appraised for internal validity (appropriateness of comparator, study design, objectiveness of measured outcomes) and mapped using a predefined coding scheme. We mapped studies according to geographical region, protected area characteristics, governance type, ecological and attitudinal outcomes, and comparator type.

Results: The evidence base is limited in terms of size, quality and geographical area. We identified 57 relevant studies across 66 articles. The evidence base is geographically confined to Latin America and South Asia. Included studies are mostly of medium level of methodological detail, but frequently lack baseline, appropriate comparator or counterfactual to establish strong causal relationships between forest PAs with a particular governance type and a specific outcome. Moreover, most of the studies assess only one, primarily ecological, outcome and there were no studies measuring spill-over effects.

Conclusions: The presented results call attention to the research gaps in the field of conservation governance, provide methodological guidelines and generate specific questions for future primary research. While conducting analysis of conservation intervention effects, research has to account for and report governance variables (e.g. how

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are decisions made and implemented). Methodological pluralism with both qualitative and quantitative approaches, more robust study designs and assessment of both social and ecological outcomes are needed to obtain a more complete understanding of the PA governance impacts.

Keywords: Community conservation, Co-management, Decisions, Institutions, Participation, People-parks interaction, Private protected areas, State parks, Top-down conservation

Background

Governance processes and structures that steer social-ecological systems and in situ forest conservation strategies such as protected areas (PAs) can be crucial for effective management and improvement of the conservation outcomes [1–3]. Governance can be defined in various ways [4] but for the purposes of this study, we define governance in the PA context as "a set of processes, procedures, resources, institutions and actors that determine how decisions are made and implemented" ([5]: 105). PAs are conservation interventions that by definition imply resource control as they consist of socially constructed set of rules such as institutions, laws and cultural norms that can guide and control resource users' behaviour and allocate access to and use of natural resources [6]. Depending on the governance setup, these rules can be imposed from above, devised and enforced externally (e.g. by state), they can be crafted by local users, self-imposed and enforced internally (e.g. by local community) or there can be a mixture of both approaches (e.g. joint governance) [3, 6, 7]. Different PA governance regimes with diverse types of institutional arrangements, different levels of involvement, accountability and responsibility by state and non-state actors that make decisions over resource use and access, may have different impacts on conservation effectiveness. Based on the number and type of actors involved, responsibility, accountability, level of power sharing, and type of knowledge used in the decision-making, governance of forest PAs can be classified after [8, 9] as: (1) governance by government, (2) shared governance, (3) private governance and (4) governance by indigenous people and local communities. However, the complexity of governance is much higher on the ground due to a variety of land tenure systems, funding sources, management bodies, access and use rights, with frequent overlaps between these four regimes [10]. We will further briefly describe each of the four governance regimes and explain what is known about how PA governance may be linked to conservation outcomes. The description below is extended and adapted from the protocol (see [11]).

Governance by government refers to a centralised governmental agency (such as ministry or park agency reporting directly to the government) that steers, enforces decisions, has authority, responsibility and accountability for PA management [9]. Planning and daily management may be also delegated to other non-state actors such as NGOs or private entities [12]. Although they could be considered as legitimate actors in delivering public benefits and could be directly accountable to the society [13], governmental agencies are often not legally obliged to take into account local voices and knowledge in the management decisions [12]. Decisions are mainly made by the remote decision-making agencies based on general scientific knowledge and technical expertise only, and lack needed sensitivity to local context [9]. The size and complexity of PAs are increasing and centralised governing bodies are often argued to be lacking sufficient knowledge, not being flexible and adaptive enough to tackle new challenges and respond to increasing uncertainty [8, 14, 15]. In developing countries with high levels of poverty and resource dependence, it is often argued that the top-down regime coupled with strict and exclusionary management practices can create high local livelihood costs and exacerbate social conflicts, also undermining conservation efforts [16, 17].

Since the mid-1980s, conservation governance started to shift from hierarchical top-down state steering to bottom-up, collaborative and community conservation. The power vested in central (national level) agencies started decentralising to local level management bodies or devolving, on paper at least, to local communities and other non-state actors from private and NGO sectors [18]. The reconfiguration of the conservation governance, greater emphasis on the participation and power diffusion to different non-state actors was induced by several forces. Globalisation and strengthening of civil society, the push of donor agencies to link conservation and rural development in developing countries, developments in scholarship on common property that emphasise the role of self-governance and self-organisation, local demands for more voice and power in the decision-making, and central government expenditure cuts contributed to the change [2, 19–21]. These "new governance" regimes (as opposed to the centralized "old governance" [22]) are detailed below.

Shared governance refers to the sharing of power, responsibility and decision-making and enforcement between the state and other non-state actors. The non-state actors can be user associations, private

entrepreneurs and landowners as well as local, mobile or indigenous communities that live and/or depend on the PA culturally or for their livelihoods [9]. Formal decision-making authority is often vested in a governmental body that is required to collaborate with other actors through a range of different formal and informal interactions: from consultation to consensus [9, 23]. This sharing of power and responsibilities is argued to increase trust among actors, foster social learning and adaptability [23]. Still, this collaborative approach can suffer from elite capture and patronage, induce power inequalities and marginalisation of the poor voiceless actors [12, 18, 24].

Private governance refers to private landowners, individuals, NGOs and other not-for profit and for-profit organisations that make and enforce decisions and have control and/or ownership over resources in PA. Private governance might be perceived as more efficient than the hierarchical bureaucracies, but their long-term sustainability may be limited, especially if the ownership changes [25, 26]. Legitimacy and accountability of private PAs may be questionable due to vested interests of funding agencies, and the reluctance of governments to grant authority or legal recognition [25, 27]. Moreover, there may be social concerns about how the land for conservation has been acquired and whether locals have been displaced in the process [26]. Often small in size, it is argued that they cannot secure the conservation of large-ranging animals and protect against habitat fragmentation [28–30] but this can be mitigated if they form a part of the larger PA network [26].

Governance by local communities and indigenous peoples is exercised through indigenous and community conserved areas (ICCAs) governed through customary laws and voluntarily conserved by indigenous groups, local and mobile communities [12]. ICCAs were first recognised as official PAs in the Durban World Park Congress and COP VII of Convention on Biological Diversity (2004) [31, 32]. ICCAs depend on government recognition as they use ethnic governance or locally arranged rules [9]. The strengths of these, sometimes very complex, regimes come from self-enforcement of the locally devised governing rules, which induce legitimacy and voluntary compliance [3, 27]. This governance regime can be vulnerable to externally induced perturbation and change, and cannot deal with the large scale biodiversity processes [33, 34]. Some authors emphasise that community-based conservation efforts are unable to deliver either positive development or ecological outcomes, but frequently the reason for their failures lies in the poor implementation and lack of real institutional reform (devolution) that can empower local communities to govern their natural resources [32, 35].

PA governance is not a new concept, but more attention has been given to it only recently—the World Park Congress in Durban 2003 brought it into focus for the first time [12]. There is a variety of research approaches to governance analysis and evaluation [4, 36]. However, systematic knowledge synthesis on how types of local governance and decision-making modes may influence conservation outcomes of forest PAs is still lacking. This is mainly because the evidence on the joint relationship between governance regimes and ecological or social outcomes is generally missing [37]. Much of the conservation governance literature consists of case studies, and studies with quasi-experimental design to infer a strong causal relationship between governance and conservation outcomes are still methodologically in a development phase; and the causal effects are hard to isolate [38, 39]. Consequently, there is no consensus on the effect of governance regimes on conservation outcomes. Moreover, the existing reviews on this or similar topics mainly focus on either social (e.g. [40]) or ecological effects (e.g. [41]) separately, and they rarely include information on governance (except some more recent reviews [42, 43]). There is potentially great value in mapping the existing evidence, creating the knowledge base and identifying knowledge gaps in the literature on the role and impact of the governance in the conservation effectiveness of forest PAs in terms of both social and ecological effects. This is a first step in evidence synthesis and the evidence mapping can enable future syntheses exercises.

Here we present results of a systematic map conducted following Collaboration for Environmental Evidence Guidelines [44]. Systematic maps are overview studies that collect, categorise and present the existing evidence on a specific topic of policy or management relevance. They are objective, transparent and repeatable tools for policy makers, practitioners and researchers to identify narrower policy and practice-relevant review questions or evidence gaps [45]. This study aims to describe and map the available qualitative and quantitative evidence from a large number and variety of sources, both peer-reviewed and grey literature, and to collate existing evidence on the impact of governance on the effectiveness of forest PAs. Therefore, we attempt to contribute to the body of previous systematic reviews on the effectiveness of PAs [42, 46] by not only collating evidence connected to "what works" but also to "when and why it works".

In order to describe the current state of the evidence base on how different governance types affect or modify conservation outcomes in forest PAs we created and followed a simple framework (Fig. 1, influenced by Ostrom's multi-tiered diagnostic approach for analysis of social-ecological systems [47, 48]). Based on a developed

strategy published in the review protocol [11] we mapped the literature on the path from a conservation intervention with a specific governance type to attitudinal, behavioural or ecological outcomes or possible changes in the surrounding social-ecological systems (spill-over effects). The choice of these specific outcomes is based on the previous reviews [49–51] so the results can be comparable. Nevertheless, here we do not consider economic outcomes of forest PAs as this has already been partially examined in Pullin et al. in their systematic review on human wellbeing impacts of terrestrial protected areas where they emphasise how "quantitative comparison of costs and benefits to local people of different forms of PA governance" is missing from the current evidence base ([42]: 35).

As stated in the protocol [11], due to high complexity and variety of conservation practices and interventions, here we focus on forest PAs only. We apply the IUCN definition of PAs in this study: PA is an area with geographical limits or boundaries; predominantly aims to achieve conservation benefits, but not excluding other related benefits (e.g. social benefits); is designated and managed by legal gazetted means or by non-gazetted, but officially recognized NGO policies or customary laws; has a body of governing rules; and has a clearly identified organization or individual with a governance authority [25]. Forest PAs can be defined as "a subset of all protected areas that includes a substantial amount of forest as defined for the purposes of Forest Protected Areas. This may be the whole or part of a protected area", excluding commercial plantations and forest managed for industrial purposes within the less strictly protected categories ([52]: 52). Moreover, forests that are managed by communities, but not predominantly aimed at biodiversity conservation are not counted as a PA in this study. Governance regimes considered in this study were state, private, community and shared PA governance. By effective conservation here we mean "positive and measurable effects of conservation policies and practices on biodiversity and target ecosystems, populations, species or habitats" ([11]: 8).

Objective of the map

Evolving objective of this research

We initially planned to conduct a full systematic review, but on preliminary appraisal of the literature we saw more value in mapping the existing evidence, describing its nature, size and knowledge gaps. We believe this is a more appropriate approach for the topic area, which appeared too broad and divergent for a single systematic review exercise. This was not foreseen during the protocol preparation aimed at guiding systematic review synthesis, but only in the later stages of the reviewing process.

Consequently, this review is created in the form of the systematic map to catalogue and collate the evidence across a wide range of criteria, such as study location and design, methodology, type of intervention and comparator. We conducted mapping and coding of the relevant full text articles.

Primary and secondary objectives

This study identifies, appraises and describes the nature and distribution of the primary research to answer: What evidence exists on the impact of governance type on the conservation effectiveness of forest protected areas?

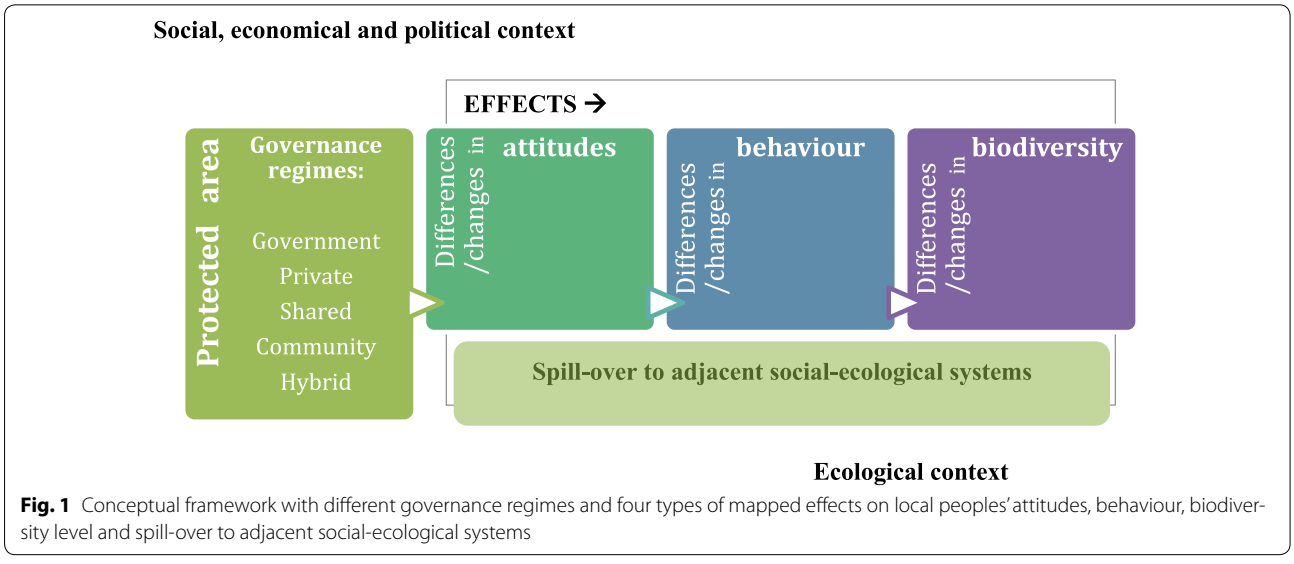

Fig. 1 Conceptual framework with different governance regimes and four types of mapped effects on local peoples' attitudes, behaviour, biodiversity level and spill-over to adjacent social-ecological systems

Specifically, we are interested in the relative impact of different governance regimes on the PA effectiveness measured by the multiple outcomes and we use evidence from comparative studies. Map question components are as follows:

Setting: Forest PAs.

Perspective: (1) Local Community; (2) PA authority/management staff.

Phenomena of interest: (1) Governmental PAs; (2) Collaborative/multistakeholder PAs; (3) Private PAs; (4) Community conserved areas; or (5) Hybrid governance regimes.

Comparator: Different governance regimes, which can include other types of PAs or other types of forests (governed by communities, state or private actors).

Outcomes: (1) Attitudinal effects measured through (difference/change in) attitudes of local stakeholders towards focal PA, authority and/or management practices (2) Behavioural effects measured through (difference/change in) level of conservation-oriented behaviour necessary to decrease the threats to natural resources (3) Ecological effects measured through (difference/change in) deforestation rate, biodiversity level, maintenance of forest cover and forest density, condition, health, etc.; and (4) Spill-over effects: social, institutional and ecological changes in surrounding social-ecological systems.

Despite the change in objective from the systematic review to systematic map, the question components, except some modification in the comparator, remain the same.

Secondary objectives and map outputs are to:

1. Create an interactive and searchable evidence database on the impact of governance in the effectiveness of PAs for use by researchers, practitioners, policymakers and the public;
2. Show the extent and distribution of the current knowledge base;
3. Identify evidence gaps according to: (a) regions and countries; (b) outcomes: ecological, social, spill-overs; (c) intervention: governance regimes;
4. Provide a preliminary and brief overview of the variations in the research quality and deficiencies in the methodology;
5. Provide directions for improvement of the quality of evidence;
6. Generate ideas for new research questions to inform a future primary research or evidence syntheses.

Methods

As this study is an evidence map rather than the full systematic review, the final methodology is different than the one published in the protocol [11]. To reflect the current state of the evidence base, we adapted primary and secondary research objectives from the protocol and did not undertake full critical appraisal, data extraction and synthesis. Moreover, we made modifications and amendments to the inclusion criteria adapted to the new objectives. We also modified the title to reflect the current map content. Full explanation of the amendments to the inclusion criteria is detailed below under section '*Amendments and clarifications to the inclusion criteria published in the protocol*'.

Searches

Search terms

To identify a suitable search string, a scoping exercise was undertaken, a search string produced and published in the protocol. The terms of the full search string include keywords connected to setting (forest PA), phenomena of interest (PA management and governance regimes) and four types of outcomes. Details of the scoping exercise along with the final search string used to extract the references from the ISI Web of Knowledge (WOK) database (and database settings used for searches) are available in Additional file 1.

The search was performed in two phases. The original search was conducted in 2012 and it was updated in March 2015. We attempted to decrease the sampling bias by using multiple sources of literature. A list of databases, search engines, specialist sources and search terms used to identify relevant literature was published in the protocol [11] and is listed below with some minor adjustments (we excluded irrelevant websites and conducted the search in two more databases). The updated search (March 2015) was conducted through the WOK database only. We based this decision on the observations from conducting the first search that resulted in a significant number of duplicates obtained through searches conducted in databases other than the WOK where the WOK had the highest number of search hits and appeared the most comprehensive database. We searched the WOK database without lemmatization, all year ranges, and in English language only.

All the search results were imported into EPPI-reviewer [53] where duplicates were removed and their number was recorded. EPPI-reviewer facilitated screening and tracking the number and sources of screened references and included articles.

Publication databases

The search included the following fifteen online databases:

1. ISI Web of knowledge
2. Scopus
3. PubMed

4. Agricola
5. Digital library of International Development Research Center
6. Scienceindex
7. Public Library of Science
8. Directory of Open Access Journals
9. COPAC
10. Social Sciences Research Network
11. Index to Theses Online
12. ProQuest (theses and journals)
13. CAB Abstracts
14. EconPapers
15. Digital Library of the Commons.

The search string was shortened in some cases, depending on the database search facility (see Additional file 2).

Organisational websites search and specialist sources

The following organizational and specialist websites (47 in total) were searched for grey literature, using multiple (3 on average), simple and shortened search strings or single key terms, depending on the search facilities of the website and details are in Additional file 3.

1. Online Knowledge Base: Natural Resources Governance around the World http://www.agter.org/
2. CGIAR System-wide Program on Collective Action and Property Rights: http://www.capri.cgiar.org/
3. CGIAR -a global agricultural research partnership: http://www.cgiar.org/
4. CATIE : http://www.catie.ac.cr/Magazin_ENG.asp?CodIdioma=ENG
5. The Community-Based Natural Resource Management Network: http://www.cbnrm.net/
6. CIFOR- Center for International Forestry Research: http://www.cifor.org/
7. Forest, Trees and People Program: http://www.cof.orst.edu/org/istf/ftpp.htm
8. RECOFCT -the Center for People and Forests: http://www.recoftc.org
9. International Society of Tropical Foresters: http://www.istf-bethesda.org/index-english.html
10. FAO Forestry: http://www.fao.org/forestry/FON/FONP/cfu/cfu-e.stm
11. FAO Document repository: http://www.fao.org/documents/en/search/init
12. FAO Catalogue online: http://www.fao.org/, http://www4.fao.org/faobib/
13. Community Forestry International: http://www.communityforestryinternational.org/
14. Conservation International: http://www.conservation.org
15. Cooperation Commons: Interdisciplinary study of cooperation and collective action. http://www.cooperationcommons.com/
16. Cultural Survival: http://www.culturalsurvival.org/current-projects/universal-periodic-review
17. Canadian Forest Service: http://cfs.nrcan.gc.ca/publications
18. The Eldis Communities: http://community.eldis.org/
19. ConserveOnline: http://conserveonline.org/
20. USAID—Development Experience Clearing House database: http://dec.usaid.gov/index.cfm
21. UK Department of International Development: http://www.dfid.gov.uk
22. Environmental change institute, Oxford University: http://www.eci.ox.ac.uk/publications/index.php
23. Eldis: http://www.eldis.org/
24. European Tropical Forest Research Network (ETFRN): http://www.etfrn.org
25. First Peoples Worldwide: http://www.firstpeoples.org/
26. Forest Trends: http://www.forest-trends.org/publications.php
27. Forests Protection Portal: http://forests.org/
28. International Fund for Agricultural Development (IFAD): http://www.ifad.org/
29. International Institute for Environment and Development: http://www.iied.org
30. Institute on Governance: http://iog.ca/
31. IUCN World Commission on Protected Areas: http://www.iucn.org/about/union/commissions/wcpa/
32. International Union of Forest Research Organizations (IUFRO): http://www.iufro.org/publications/
33. World's Environmental Library: http://www.nzdl.org/fast-cgi-bin/library?a=p&p=about&c=envl
34. World Wildlife Fund For Nature: http://wwf.panda.org
35. Poverty and Conservation: http://povertyandconservation.info/en/bibliographies
36. Protected areas and governance group-site: http://protectedareasandgovernance.groupsite.com
37. Rainforest Portal: http://www.rainforestportal.org/
38. Oxford Centre for Tropical Forests: http://www.tropicalforests.ox.ac.uk
39. United Nations: http://www.un.org/en/
40. United Nations Development Programme: http://www.undp.org/
41. Global Environmental Facility (GEF): http://web.undp.org/gef/gef_library.shtml
42. GEF -Small Grants Programme: http://sgp.undp.org/
43. UNEP-WCMC World Conservation Monitoring Centre: http://www.unep-wcmc.org/

44. United Nations Environmental Programme: http://www.unep.org, http://ekh.unep.org/
45. Wildlife conservation Society: http://www.wcs.org
46. World Bank: http://web.worldbank.org
47. Nature Conservation Research Centre: http://www.ncrc-ghana.org/.

Estimating the comprehensiveness of the search

The comprehensiveness of the search was estimated and improved by searching through bibliographic and Internet sources:

(a) Supplementary bibliographic search

We searched manually through bibliographies of 10 relevant key reviews to check if all the relevant articles were identified in the previous searches. We included missing relevant articles. The results of this search are in Additional file 4.

(b) Internet search

We used Google Scholar (http://www.scholar.google.com) to check the comprehensiveness of the search. We used 4 different shorter search strings, as the original search string was too long. For each string we screened the first 160 hits (this is empirically-informed cut-off point based on the decreasing relevance of the hits). The results of this search are in Additional file 5.

Article retrieval

We retrieved full text articles digitally (as PDF files) and where needed, we used subscriptions of Bangor and Padua Universities. Where we did not have access to the articles, we contacted authors directly when possible (via email or ResearchGate).

Article screening and study inclusion criteria

According to the inclusion criteria presented below, the first author screened and included studies through three stages. First, titles, thereafter the abstracts and finally, the full-text articles were assessed against the inclusion criteria. Grey literature was screened directly at the full text level, as there are frequently no abstracts in these publications.

In order to check the consistency of inclusion, all three authors independently reviewed a small set of abstracts (N = 78). Inclusion decisions were compared and all disagreements were discussed. The inclusion criteria were clarified and improved before continuing with the screening procedure of remaining abstracts. The identical procedure was applied for the full-text screening on a sample of 12 articles. Causes of disagreement stemmed from doubts over whether the study contained sufficient information on governance regime and later, if the comparator was appropriate.

We applied the following inclusion criteria while screening studies:

Relevant population: Forest PAs with or without human populations

Relevant interventions/phenomena of interest: State, collaborative or joint, private and community regimes of governance as well as informal forms of governing through local institutions;

Relevant comparators: Comparisons of (1) governance regime that changed over time in a single PA; (2) PAs with different governance regimes; (3) PAs with managed forests with defined governance regime;

Relevant outcomes

1. Changes or differences in attitudes of local stakeholders towards focal PA governance, authority and/or management practices;
2. Changes or differences in level of conservation-oriented behaviour reported to decrease the threats to natural resources;
3. Changes or difference in deforestation rate, biodiversity level within a forest ecosystem, maintenance of forest cover and forest density, condition, health (including fires) or any other biodiversity indicator;
4. Social, institutional and ecological changes around PA and at the local level that may have increased pressures on resources outside a focal forest PA (leakage or policy side effects).

Language: English only.

Publication date: No date restrictions were applied during the inclusion.

Geographical limits: No geographical limitations were applied during the inclusion.

Studies that could not be obtained are listed in Additional file 6. Excluded studies are listed along with reasons for exclusion in Additional file 7.

Amendments and clarifications to the inclusion criteria published in the protocol

One of the inclusion criteria from the protocol was that a potentially relevant study should report not less than two outcome types. We disregarded this criterion as the majority of the studies had only one outcome. We focused only on studies that were conducted at the local scale, and studies on regional and national scales, e.g. analysing national-level conservation policy and their outcomes, were rejected. Studies describing PA establishment (or conflicts prior to establishment) were not included. Moreover, studies on the introduction of new institutional mechanisms and outreach projects (such

as the establishment of local community management committees, integrated conservation and development projects (ICDPs)) were frequently missing required outcomes (despite of sufficient details on the processes and governance regime) and therefore excluded. We included studies on ICDPs only if they are formulated as a specific collaborative regime between PA managers and local people and we excluded them if they are presented as purely an incentive or compensation project and without inclusion of local people in the decisions connected to conservation or park management. Four articles describing the informal PAs, such as sacred groves, are added to the map. We decided to include these four studies as they were well designed and compared informal conservation interventions with the state forests. We have retained them in the map as they can provide an example of required study designs as well as valuable evidence for further research. More details are explained in the discussion. Studies on mangrove PAs were included too in accordance with the IUCN guidelines on the definitions of forest PAs [54]. We extended definition of the comparator. Studies with a comparator other than formal PAs were also included. These comparators were other types of forests under various governance regimes (communities, state or private) and this is noted in the map.

Study coding

Articles selected for full-text inclusion were exported from EPPI reviewer to a spreadsheet where we applied coding of the reported studies.

Coding was undertaken using the full-text and predefined variables generated from the primary question and connected to the various aspects of study setting and design, including the information on the article, type of methodology used, type of governance, description of outcomes and comparators. Some of the codes were based on the topics reported in the articles and were identified and added to the database during the mapping process. The coding tool with definitions of codes is described in Additional file 8.

Each line in the database represents a single study. Articles that report part of the bigger study (same group of authors, research spanning over same years and within the same research location) have been entered as separate lines in the database, but they are marked as "linked studies" and connected with the same study ID number. Moreover, if the article is not a stand-alone article, but just gives the contextual information to the main study, this is marked as a "background study".

The first author coded all the studies and the other two authors checked coding consistency by reviewing coding decisions on a small sample of included studies (N = 7). All disagreements were discussed and coding consistency was adjusted accordingly. The first author coded the rest of the studies with the frequent discussion of any doubt with the other authors.

Critical appraisal

The database includes general comments on the internal validity of the studies and the potential biases in the methodology. External validity was not assessed. Specifically, we coded four different variables: (1) the level of methodological detail (low, medium and high; similar to Brooks et al. [49]), (2) appropriateness of the comparator (descriptive category); (3) type of measurements of ecological or behavioural outcomes (subjective and perception based or objective, measured with the specific instruments), and (4) study design.

The first author critically appraised all the studies. A subset of studies (N = 7) was critically appraised by all three authors. All authors tested for consistency of critical appraisal and once we were satisfied that we had reached consensus on decisions, the first author completed the tasks with frequent discussion of any doubt with the other authors.

Table 1 provides an overview of the critical appraisal coding system. More detailed definitions of the critical appraisal variables and their coding system are in Additional file 8. We extracted the characteristics of the studies that might be useful for judgement of reliability in future evidence syntheses, but we have not undertaken the full quality appraisal.

Results

Evidence identification, retrieval and screening

All steps in evidence identification, retrieval and screening, along with the numbers of included and excluded studies at different stages of the mapping process are depicted in Fig. 2.

Searches of academic literature databases, undertaken in July and November 2012 and updated in March 2015 identified 8039 potentially relevant titles (this includes 1256 potentially relevant titles from the updated search). Additional sources, such as bibliographic checking (=163), references extracted from other articles (=9) and Google Scholar search (=640) yielded an additional 812 articles. After duplicate removal (=2422), 6429 articles were screened at the title level out of which 2021 titles were identified as relevant and were screened at abstract level. 910 abstracts were identified for the full-text screening, while 1111 abstracts were excluded. Moreover, searching through organizational websites resulted in additional 118 potentially relevant articles (duplicates deleted: 1). We screened 883 articles at the full-text level and we could not assess 145 full-text articles due to lack of institutional subscription

Table 1 Elements of critical appraisal and their coding (Study designs categorisation adapted from [71, 72])

1. Study design	Case study: in-depth non-experimental qualitative study of a single location/protected area/local community within, usually studied over time in a real life context, using documents, interviews, observations. Frequently reports on unusual, extreme or rare cases Case series or Time series: quantitative non-experimental study in multiple time periods, outcomes measured during the intervention. If measurements exist before and after intervention—Before-After (BA) design Cross-sectional study (Control-impact (CI)): quantitative non-experimental study conducted in one point of time (e.g. survey), provides a snapshot. Not clearly established if intervention preceded the measured outcomes. Has non-randomly selected control groups Controlled before-and-after study (Before-After-Control-Impact (BACI)): quasi-experiment with controls, measure of outcomes before and after the intervention Controlled after only study: quasi-experiment with controls, measure of outcomes after the intervention ONLY Sequential mixed method: qual > quant OR quan > qual Concurrent mixed method design: qual and quant at the same time
2. Comparator appropriateness	Is comparator appropriate for governance assessment? Is it relevant for the stated aims and conclusions of the study? Other methodological details? Describe
3. Methodological detail	LOW = no sufficient details on data collection and/or data analysis procedures, method selection not justified, MEDIUM = no important methodological details missing, selection of methods justified and fits the research question; HIGH = very detailed explanation of the data collection and analysis procedures, info on ethical approval included, study limitation, confounding and biases commented upon
4. Measurements of ecological outcomes	Subjective/perception based or self-reported (=0); Objective (=1). E.g.: changes in the forest cover assessed through analysis of satellite images versus perception of the changes in forest cover reported by the local people)

(=125) or because publications were not in English (=20).

At the full-text screening step we excluded 817 articles. Reasons for exclusion were: not a primary research study (e.g. relevant review without empirical data), (=95), country-level analysis (e.g. a national level forest conservation policy assessment) (=21), no appropriate comparator (comparator lacking or it is simple inside/outside comparison) (=144), irrelevant intervention (e.g. agroforestry) (=111), no relevant outcomes (e.g. focus on the economic costs of PAs only or on PA governance processes only) (=175), insufficient information on governance (i.e. no detailed explanation on governing and management bodies), (=241), non-forest PAs (=30).

In total, we coded 66 articles that correspond to 57 studies. To be a part of a single study, articles had to be authored by the same group of authors, where research is conducted in the same or similar time period and in the same location.

Systematic map database

A searchable systematic map database was created aimed at describing the scope of the current research, evidence type and location. The database is provided in Additional file 9. The map can be searched through different keywords and attributes at the article or study level, to provide insights into the knowledge base size and gaps (in terms of geographical location, governance type, outcome, methodology) and to be a source of questions for future systematic reviews.

Database description and findings

Below is the descriptive summary of the database. Information on PA sizes and year of establishment, a link to the World Database on Protected Areas (protectedplanet.net) and many other relevant details can be found in the Additional file 9.

We included 9 background publications that could not be stand-alone studies, but served as a contextual support to the main publication in the study by providing background on governance processes or describing additional outcomes.

The oldest included article was published in 2002. 46.97 % of all the included relevant articles were published from 2010 to 2014.

Figure 3 shows the yearly increase of published relevant articles.

Academic authors published the majority of the articles included in this map (60.6 % or 40 out of 66) and this was followed by a combined authorship between academic and NGO-affiliated authors (22.72 %, 15 out of 66). Almost all of the included publications were peer-reviewed (98.5 %, 65 out of 66), out of which 84.8 % were journal articles. The majority of the studies included in the map applied quantitative (34 studies; 59.6 %) and mixed methods (15; 26.3 %), while qualitative studies were represented to a lesser extent (8; 14 %). One out of 57 included studies was a simulated experiment [55], three were quasi-experimental studies and the rest were observational studies.

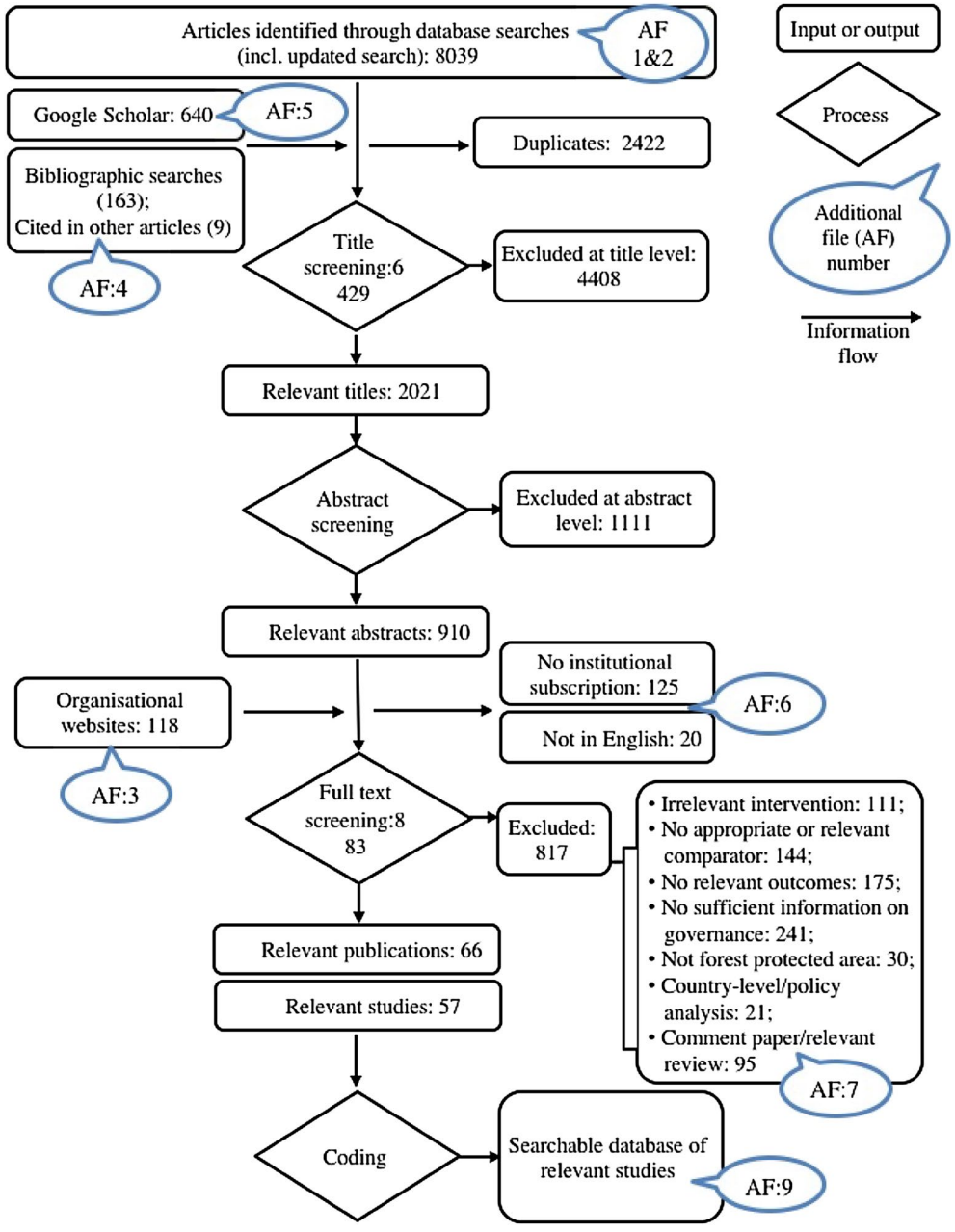

Fig. 2 The flow diagram of mapping stages from searching, identification of relevant literature and coding. The locations of the outputs of specific mapping stages placed in the additional files (AF) are also depicted

Research locations of the included observational and quasi-experimental studies were placed in 26 countries. Studies were mainly located in Latin America (35 study locations) and Asia (=17), while only a few studies were located in Europe (=5) and Africa (=5). Mexico was the most studied country (7 studies) followed by Nepal (=6), India (=5), Bolivia (=5) and Brazil (=5) (Fig. 4). Most of the studies were located in a single country (50 studies), while only five studies had included two countries, and only one study showed cases from three countries.

In 28 studies (out of 56 observational and quasi-experimental studies; 50 %) the information on IUCN management categories was not available. For several included studies this information could not be obtained for all the PAs in the sample since IUCN management categories were not reported (either in the publication or

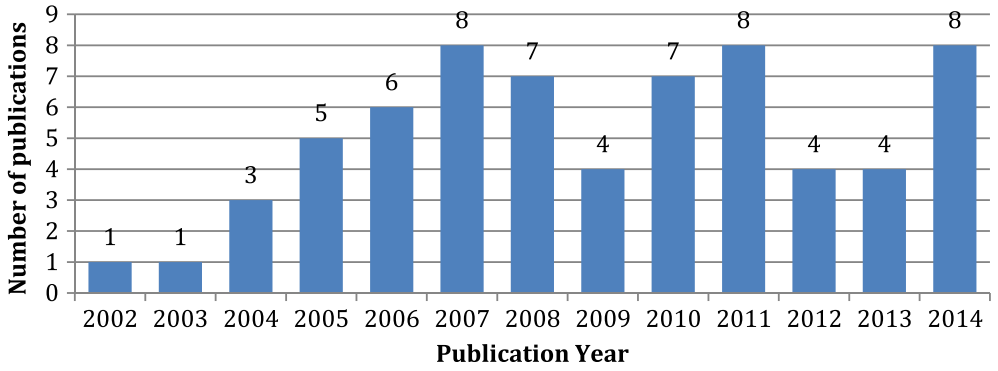

Fig. 3 Number of articles included in the map by publication year (total number of included articles is 66)

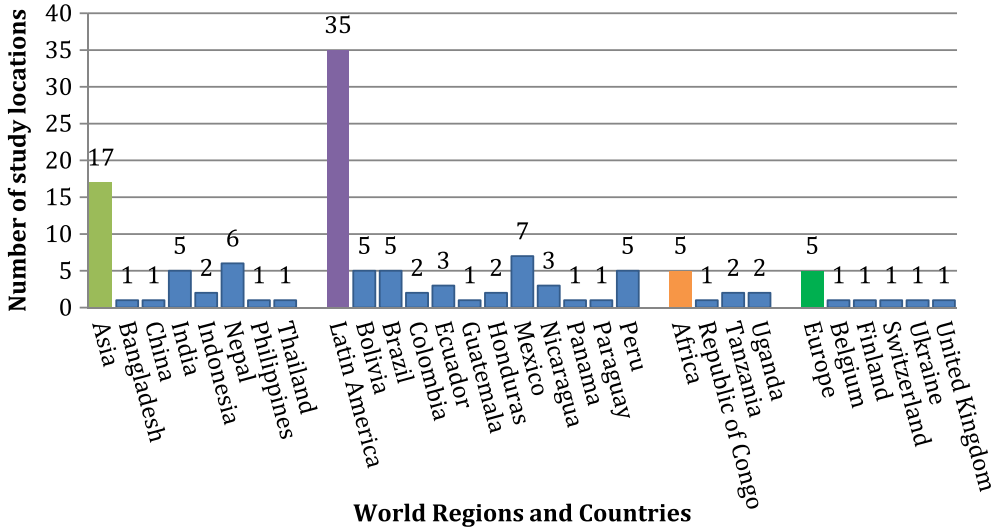

Fig. 4 Number of study locations per country and per continent/region. Locations within multi-site studies are counted separately

on protectedplanet.net), or studied forests could not be categorised (e.g. sacred groves and other informal PAs). Where this information was available, IUCN management categories of studied PAs were various: from II to VI (only one publication was dealing with PAs under management category I), implying high variability of resource access and strictness levels.

There was a high variability in sample sizes, which stems from differences in study and sampling designs used across mapped studies. Out of 56 observational and quasi-experimental studies, 15 focused on only one PA, 8 studies focused on two PAs. The rest of the studies (33 or 59 %) encompassed three or more (formal and informal) PAs in the analysis, including adjacent forest patches of different governance, ownership or tenure regime. The highest number of PAs compared in a study was 292 [37] followed by 163 [56].

Variety of reported outcomes

Most of the studies reported only one outcome (45 studies) predominantly measuring only ecological effects (38 studies). Nine studies reported two outcomes out of which five studies focused on both social and ecological effects and the rest measured two types of social effects. Three included studies reported three outcomes (ecological, behavioural and attitudinal [57–59]). Spillover effects or "neighbourhood leakage" [60] were not captured by our map. Studies that reported on the spillover effects were missing (sufficient) information on governance regimes and were excluded (Table 2). Ecological outcomes reported were: (1) forest cover change: annual deforestation rate (e.g. [61, 62]), fragmentation (e.g. [63, 64]), rate of forest regeneration (e.g. [65]); avoided deforestation (e.g. [66]); (2) biodiversity assessment through: species richness, density, abundance (e.g.

Table 2 Number and kind of reported outcomes per study (total number of mapped studies is 57)

Studied outcome types	Ecological	Attitudes	Behaviour	Spill-over	Total no. of studies
Four	0	0	0	0	0
Three	3	3	3	0	3
Two	5	6	7	0	9
One	38	2	5	0	45

[67–70]); forest stand inventories (e.g. [71, 72]., forest community structure: density and composition, occurrence of endemic, threatened species and medicinal species (e.g. [73, 74]), biomass (e.g. [55]) as well as fire effects (e.g. [56, 75]). Attitudinal outcomes reported were: level of trust or satisfaction of local people towards management authorities (e.g. [76, 77]), attitudes towards PA (e.g. [78, 79]), rules [59], conservation practice and biodiversity (e.g. [80]). Behavioural outcomes reported were: changes to collaborative behaviour (e.g. [81–83]); monitoring and sanctioning [70]; occupation/livelihood strategy changes (e.g. [84, 85]); conflicts with PA authorities (e.g. [86]: mobilization of large groups/politicians, feigning ignorance, not turning up for meetings, letting roads become overgrown, bribing park staff and moving boundary markers); non-compliance: illegal activities [57] and encroachment [87], hunting (e.g. [58, 88]), non-conservation oriented behaviour and resource extraction [83, 89, 90].

Governance regimes

Included studies contained analyses and compared all four governance types, including state, community, private (incl. NGO-governed) and co-governed multistakeholder PAs with various and often complex combinations of land tenure systems, involvement of external actors and power sharing. More detailed information on governance characteristics, such as nature of stakeholder participation, level of decentralization, level and nature of collaboration among actors was frequently lacking in the majority of the studies and these variables were not coded (as initially planed [11]).

The majority of studies (N = 51) included state governance type in a comparative analysis. The study by Mehring and colleagues [89] analysed a state PA that includes community conservation, with negotiated conservation agreements and was classified under state PA governance.

Forty-two studies encompassed some form of community governance and this included forests managed for religious purposes such as sacred groves (e.g. [73]), indigenous reserves and territories (e.g. [56]), extractive reserves (e.g. [91]), community concessions (e.g. [63]), community or decentralized forests (e.g. [87]) or communal lands such as *ejidos* in Mexico (e.g. [92]).

Twenty studies included some form of governance by private actors out of which six studies included private PAs owned by an individual, a company, NGOs or non-for-profit trust foundation [79, 88, 93–96]. A study by Mönkkönen et al. [74] investigated voluntary conservation agreements on the private forests in Finland. The rest of the studies included mostly forest concessions (managed not only for conservation purposes) that were used as a comparator to other conservation governance regimes.

Twelve studies included co-managed PAs or some other form of participatory conservation out of which two studies [80, 84] described the effects of integrated conservation and development projects within state PAs.

Some studies could not be easily classified under the four governance regimes. Annapurna conservation area in Nepal has a complex governance setting with community-led committees inside a national PA, managed by a NGO/trust [76]. Quintana and Morse [79] included a state-run PA with private land ownership, and this was coded as the state governance in this map. Vallino [55] simulated external law enforcement, application of internal rules and open access scenarios in conservation and forest management. Figure 5 gives an overview of the governance regimes in the included studies.

Comparator types

Out of 57 studies, 10 studies compared governance within the same PA over time, 15 studies compared different PA governance regimes; and 2 studies compared intervention against no intervention. 30 studies compared PAs with various governance regimes against similar forestry areas under private concessions, or community forestry patches outside the PAs. Figure 6 provides an overview of the nature of comparators and Table 3 shows all the included studies, mapped outcomes, comparators and governance types.

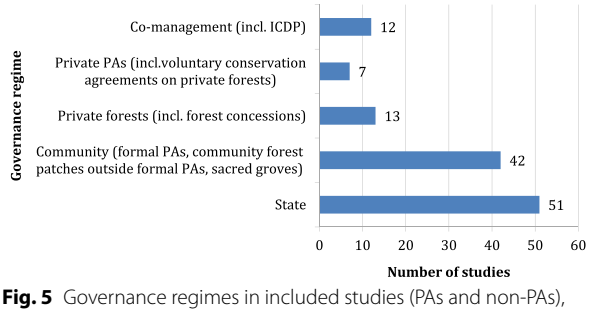

Fig. 5 Governance regimes in included studies (PAs and non-PAs), coarsely grouped (N = 57)

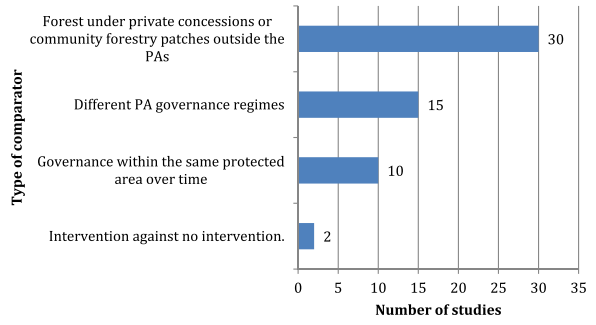

Fig. 6 Nature of study comparators in included studies (N = 57)

Mapping the quality of the studies relevant to the question

Study design

Twelve studies were classified as a case study. One study was described as a comparative case synthesis [87] and one as a simulated experiment [55]. Twenty studies were categorised as time series with site comparison. Three studies were designed as "before-after" [58, 84, 97]. Fifteen studies had cross-sectional study design (site comparison in one time point). One study was designed as control-impact [80]. Only four studies had before/after/control/impact (BACI) design [37, 66, 83, 98]. Study design details are in Fig. 7.

Appropriateness of comparator

Out of 48 observational and quasi-experimental quantitative and mixed method studies, 39 (81.25 %) had no baseline data at all and they were either simple site comparisons or time-series (Fig. 8). Four studies (8.33 %) had baseline collected through recall and people's perceptions [81, 84, 86, 99]. One study had simple before-after comparator in a single PA [97]. Only four (8.33 %) studies had appropriate comparator [37, 66, 83, 98], out of that number three studies used matching methods to create a counterfactual and control for observational bias [37, 66, 98].

Level of methodological details

Most of the studies (N = 47) had a medium level of methodological detail with sufficient details on data collection and analysis procedures, and justified selection of methods. Nevertheless, most of the studies lacked an explanation of study limitations and did not comment upon potential biases in data collection, analysis or reporting. Three included studies had a low level and seven studies had a high level of methodological detail.

Objectivity of measurements

Out of 46 studies reporting ecological outcomes, 38 studies used objective measurements of ecological outcomes, 4 studies used subjective measurements to report ecological outcomes (self-reported, observation or perception–based). Three more studies used mixed subjective and objective measurements to report different ecological outcomes. One study simulated the outcomes through agent-based modelling. Here we were not assessing the objectivity of the studies measuring attitudes or behavioural outcomes as these studies report perception-based or self-reported data.

Discussion

Mapping limitations

Crossing qual-quant divide

This evidence map encompasses mainly quantitative studies. Quantitative studies more often had all the information to fit into our inclusion criteria, but they also frequently lack an explanation of contextual variables that can provide important details for more complete understanding of the local-level PA governance and its effects. Available qualitative studies were mostly in-depth case studies, typically describing various forms of park-people conflicts, predominantly on the state-community power continuum. Building an in-depth understanding of governance processes with qualitative methods is certainly not inappropriate or limiting, but most of these studies could not fit our inclusion criteria as they were focusing solely on the governance or institutional processes without reporting required outcomes or without a comparator. Our focus on the research approaches that included comparator and appropriate counterfactual allowed for mapping studies that can provide the evidence of cause and effect relationships between governance and conservation outcomes, but we often lost rich governance-related information of qualitative studies.

Mapping complex interventions

Collating evidence on complex interventions with many interrelated and independent components might be a challenge, especially when it comes to common definitions, categorization and finally, the synthesis. Depending on the national conservation governance regime, some PAs had multiple and overlapping governance and institutional arrangements within a single PA. For example, studies by Baral and colleagues [27, 100] described the case of Annapurna Conservation Area in Nepal, where PA land was owned by the state, management was given to a NGO/trust, and there were local community committees. Similarly, in Mexico mapped studies focused on the effects of different tenure arrangements within and around PAs (e.g. state PAs with *ejidos* (communal lands)) on the state of the biodiversity or land use change (e.g. [101]). In other cases in Central and South America, there is an overlap between indigenous territories and state-owned PAs. Typically, PAs entail zones

Table 3 Overview of the mapped governance regimes, outcomes and comparators

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
101	Armenteras et al. [61]	Various in Colombian Guyana Shield: Chiribiquete, Macarena, Nukak, Puinaway. Tuparro, Barranco Colorado, Barranquillita, Cano Mesetas-Dagua y Murcielago, El itilla, Cano Bachaco Guaripa, La Hormiga y Guacamayas Maipore, Lagos del Dorado, Lagos del paso, Bacat-Arara, Vuelta del Alivio, Yabilla II, Barranco Ceiba y Lag, Cano Jabon, Cuenca Media y alta del rio Inirida, Nukak Maku, Parte alta del rio Guainia, Remanso Chorro Bocon, Rios Cuiari e Isana, Tonina-Sejal-San Jose, La Fuga, La Sal, Llanos de Yari (Yaguara II), Piaroa de Cachicamo, Puerto Nare, Puerto Viejo y puerto Esperanza, Tucan de Caño Giriza La Palma	1	Land cover changes between 1985 and 2002 (%)	1 and 4 (national and indigenous reserves)	2 (incl. inside/outside comparison)
102	Bajracharya et al. [58]	Annapurna Conservation Area	1, 2, 3	(1) Ecological: Density, basal area, species diversity and species evenness of all the trees ≥10 cm DBH; wildlife abundance changes; (2) Behaviour: resource use and hunting behaviour (count and sighting), (3) Attitudes: attitudes towards conservation (percentage agree)	4	1: Other: local people's perceptions of change (1), also compared with adjacent areas under traditional forms of land use (but no information on governance there)
103	Baral and Stern [76]	Annapurna Conservation Area, various community forests	1, 2	(1) Ecological: improvement of the state of natural resources and effective conservation efforts (scale and percentage agree); (2) Social: Trust towards administering bodies and feeling of their importance (scale 1–5 and %)	Other: 1, 3, 4: community-led committees inside national PA managed by a NGO/trust compared to state managed community-led committees outside PA	2

Table 3 continued

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
104	Bhagwat et al. [73]	Sacred groves in Kodagu District, Karnataka	1	Trees, birds, and macro-fungi: Diversity, species distribution and attributes: pairwise similarity in species composition, comparison between sites in habitat preferences, occurrence of endemic and threatened species, and useful and medicinal species	1, 4 [informal community based governance (sacred groves)], surrounding landscape with coffee plantations	3
105	Bray et al. [63]	Calakmul Biosphere Reserve (CBR, Mexico) and Maya Biosphere Reserve (MBR, Guatemala)	1	Mean annual deforestation rate (%)	1, 4 (community concessions)	3
106	Chowdhury [119]	Calakmul Biosphere Reserve	1	Land cover change (in km^2) and persistence (Per cent of cover class in date 1 that transitioned (or not) in date 2)	1 (including within and around the Reserve comparisons), 2, 4 (*ejidos*)	3
107	De Clercq et al. [93]	Various—not stated	1	Mean change in spatial forest cover pattern (ha) and fragmentation	1, 3	2
108	Dressler WH et al. [85]	Puerto Princesa Subterranean River National Park	3	Behavioural change (Sweden farmers/indigenous versus paddy farmers/migrants) under different governance regimes	1, 4, 5 (decentralization and devolved governance)	1
109	Gubbi et al. [80]	Periyar Tiger Reserve	2	Attitudes towards conservation and towards PA (scores)	1 (incl.5 through Integrated Conservation and Development project)	Other: no intervention versus intervention
110	Hayes [59]	Río Plátano Biosphere Reserve (RPBR, Honduras) and Bosawas Biosphere Reserve (BBR, Nicaragua)	1, 2, 3	(1) Ecological/(2) behaviour: Agricultural expansion (encroachment activities) produced by mestizo migration (Land cover change for period 1995–2001 in ha); (3) Attitudes: attitudes towards the rules (% agree)	1 (RPBR), 4 (indigenous, BBR)	2
111	Hayes et al. [87]	Río Plátano (Honduras), Bosawas (Nicaragua); Baga II, Baga I, Sagara (Tanzania)	1, 3	Conservation outcomes scores composed of: (1) ecological/(2) behaviour: (a) Mesoamerican case: deforestation trends (encroachment level), (b) Tanzania: forest structure measures (basal area, stem density, and mean tree DBH), species composition, incidence of illegal logging	1, 4, 5	3 (Tanzania: not PA)

Table 3 continued

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
112	Johnson and Nelson [77]	Lagunas de Montebello National Park (LMNP)	1, 2	(1) Ecological: vegetative cover type, regeneration (1/0), and pests (in *Pinus spp.)* (1/0), extent of groundcover, human activity, and indication and degree of burns (0–3); (2) Attitudes: relationship with external authorities	1, 4	2
113	Stokes et al. [67]	Nouabale-Ndoki National Park (NNNP), Lac Telé Community Reserve (LTCR) and some Forestry Management Units (FMUs)	1	Abundance of elephants (dung density (Dung piles/km^2) and individual density (Inds/km^2)), gorillas and chimpanzees (nest density (Nests/km^2) and individual density (Inds/km^2)	1, 4 and joined state/private/NGO governance of forest management units	3
114	Kubo H et al. [81]	Gunung Halimun-Salak National Park	2, 3	(1) Attitudes: perceptions, attitudes, trust and (2) Behaviour (stated, not measured) of both field staff and local people towards conservation and park (percentage of agree)	1 and "participatory" (educative and consultative participation)	1
115	Licona et al. [14]	Biosphere Reserve composed of Bahuaja-Sonene National Park (core) with Tambopata National Reserve (core) and a buffer zone; Native Community of Infierno	1	Ungulate numbers (white-lipped peccary; collared peccary; lowland tapir; red brocket deer)	1, 4	3
116	Forrest et al. [62]	Madidi National Park (MNP), Madidi Integrated Management Area (MIMA), Tacana Indigenous Territory (TCO), forestry concessions	1	Rate of forest cover change over different management regimes (annual per cent change)	1, 2 (private concessions), 4 (indigenous),	3
117	Mehring et al. [89]	Lore Lindu forest Biosphere Reserve	3	Perceptions of resource extraction (scale)	Other: 1 with community conservation agreements negotiated with the help of NGOs	1
118	Mena et al. [127]	Cuyabeno Wildlife Reserve (and adjacent Patrimonial forests)	1	Rate of forest cover change (ha, %)	1 and 4 (communities manage and have usufruct rights, land is under state ownership)	3 (PA versus patrimony (community) forest (outside)
119	Mgumia et al. [71]	8 Sacred groves (miombo woodlands):Mmeta I, Kalomo, Msago I, Mbeleka I, Ndisha, Mmeta II, Mbeleka II and Msago II and Uganda State Forest Reserve (USFR)	1	Stem density (1/ha), stem basal area (m2/ha), species richness, Shannon-Wiener index, evenness, number of plant families,	1, 4 (sacred grove)	3
120	Monkkonen et al. [74]	Various Voluntary Conservation Sites, Managed Forests, Private Forests	1	Biodiversity: dead wood (DBH, length), lichens and fungi	Other: Private: Voluntary Conservation Agreements (for compensation), private managed forests	Other: Private forest management with and without voluntary conservation programme (compensation based)

Table 3 continued

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
121	Mugisha et al. [57]	Protected areas with a community-based conservation approach: (1) Murchison Falls (MF), (2) Kibale, (3) Queen Elizabeth (QE), (4) Lake Mburo (LM), (5) Bwindi, (6) Mgahinga and (7) Mount Elgon (ME). PAs with a conventional management approach: (8) Karuma, (9) Bugungu, (10) Semuliki, (11) Kigezi, (12) Katonga, (13) Pian-Upe (PU), (14) Bokora, (15) Matheniko and (16) Kidepo Valley (KV)	1, 2, 3	Threat reduction assessment method/perceptions of conservation performance and outcomes,: (1) Ecological: deforestation; (2) Behaviour: illegal activities, (3) Attitudes: attitudes towards management staff and other practices (percentage agree, scales)	1, 4	2
122	Nagendra [99]	Royal Chitwan National Park and other adjacent 2 locations	1	Measured: tree and sapling species richness, species diversity, density, DBH and height; Perceptions: vegetation density and of species diversity (perceptions of a forester, scale); Forest change: density of tree cover, shrub and bush cover, ground cover: (local people perceptions, scale)	1 (national park and national forests), 4 (community forests)	3
123	Nagendra et al. [128]	Celaque National Park (CNP), Royal Chitawan NP (RCNP)	1	Rate of forest cover change (stable, regrowth, deforestation %) in the core, buffer and 5 km surrounding area	Other: (1) State park without participation, *ejidos* and private land owners inside park and (2) State park with participation in the buffer zone (started in 1995) with the state tenure	2
124	Nagendra H et al. [65]	Royal Chitwan National Park	1	Land cover change over time (% deforested, % regrowth, % degraded, %reforestation, % stable); forest fragmentation: Mean patch area (ha). Mean patch nearest neighbour distance (m), Mean patch shape index, Patch density (1/ha)	1, 4, 5 [(1) a national park; (2) a designated park buffer involving participatory forest management programs; (3) scattered patches of designated community forest; and (4) large areas of adjacent landscape made up of mostly private landholdings under agricultural practices]	3
125	Nautiyal et al. [72]	Nanda-Devi Biosphere Reserve and surrounding forests	1	Tree species inventory and forest structure: Density (1/ha) and basal cover m2/ha of tree, tree seedlings and shrub species), vegetation index values, temporal vegetation dynamics (%)	1 (GCF, PAF), 4 (TCF/Sacred forests, CCF),	3
126	Negroes et al. [68]	Cantao State Park (CSP), Santa Fe Ranch(SFR)	1	Species richness/relative abundance index (mammal) and activity (mammals and birds)	1 (public PA), 2 (private forest fragment)	3

Table 3 continued

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
127	Nepstad et al. [75]	Various—Brazilian Amazon	1	The ratio of deforestation (average annual deforestation rates from 1997 to 2000 within 10-km-wide strips of land located along the inside and outside of the reserve perimeter) and fire inhibition (fire density (number of fires per square kilometre in 1998) within 20-km-wide strips along the inside and outside of the reserve perimeter)	1, 4 (indigenous)	3 (incl. inside -out)
128	Newton [120]	New Forest National Park	1	Biodiversity (number of large mammals), Declines and losses of different species group (descriptive)	1, 4	1
129	Oliveira et al. [121]	Various national parks, indigenous territories, forest concessions (all names not stated)	1	Annual rates of forest damage extent and intensity -disturb and deforested (km^2/y),	1, 2 (concession production forests), 4 (Indigenous land and reserves for tribes in voluntary isolation),	3
130	Quintana et al. [79]	Mbaracayu Natural Forest Reserve (private) (MNFR) and San Rafael Managed Resource Reserve (state) (SRMRR)	2, 3	(1) Attitudes: relationships between the management bodies of the reserves and other stakeholders (descriptive), attitudes towards reserve (descriptive), (2) Behaviour: conflicts (descriptive)	1 (state as managers, private landowners), 3 (NGO as a management authority and landowner)	2
131	Rao et al. [104]	Sacred groves (Sadasivakona (SDK), Singirikona (SGK), Kailasakona (KLK), Bupathayyakona (BTK), and Talakona (TKN)) and Reserved forests (RF1-5) in Eastern Ghats	1	Species richness and density(count), basal area (cm), site disturbances: cut stumps, fire, grazing, lopping, invasive species (score)	1 (reserved forests), 4 (sacred groves)	3
132	Rueda [92]	Calakmul Biosphere Reserve and other *ejidos*	1	Deforestation rate (km^2)	1, 4 (*ejidos*-communal agricultural land)	3
133	Sanchez-Azofeifa et al. [96]	Chamela-Cuixmala Biosphere Reserve and surrounding *ejidos*	1	Forest cover (difference) between CCBR and *ejidos* (%)	2, 4 (*ejidos*)	3
134	Stocks et al. [122]	Bosawas Biosphere Reserve (BBR)	1	Spatial and temporal differences in forest cover (km^2)	2 (colonists), 4 (indigenous)	2
135	Thaworn et al. [82]	Sri Nakarin Dam National Park (SNDNP), Chalerm Rattanakosin Forest Reserve (CRFR)	3	Change of behaviour: from various conflicts (resistance, encroaching) to collaboration (protection, voluntary conservation groups, fire watchers, etc.)	1, 5	2

Table 3 continued

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
136	Ting et al. [83]	Bai-shuijiang National Natural Reserve	3	Difference in dependency on forest resource: Firewood consumption, non-timber forest product value, livestock breeding (2006-2010), households' firewood consumption, livestock breeding (site comparison)	1, 5	1 (before-after: with and without community involvement through community-based co-management project)
137	Urquiza-Haas et al. [88]	Sian Khan Biosphere reserve and other *ejidos* and private forests (El Zapotal Private Reserve; Tezoco Nuevo ejido; Yodzonot Laguna, Otoch Ma'ax Yetel Kooh protected area, Valladolid ejido; X-Conha ejido, forestry polygon 1, polygon designated for agricultural activities 2; Las Palmas private property; Sian Ka'an-Uaymil, Sian Ka'an Biosphere Reserve; Uaymil protected area; Uninhabited private properties; Tierra Negra ejido]	1, 3	(1) Ecological: Encounter rates/abundance of mammal and bird species, (2) Behaviour: hunting pressure (perceptions and direct sighting of hunting tools—scale)	2, 3, 4 (*ejidos*/communal landholding)	3
138	Van Gils et al. [95]	Carrasco Ichilo National Park	1	Proportion (%) of converted closed forest (CCF) between 1986 and 2002 within each land tenure regime	1, 3, 4	2
139	Vuohelainen et al. [94]	Reserva Nacional Tambopata (RNT), Comunidad Nativa Infierno (CNI), Comunidad Nativa Palma Real (CNPR), Comunidad Nativa Boca Pariamanu (CNBR), Shihuahuaco (5), Picaflor Research Centre (PRC), Amarumayo (7), Reserva Ecologica Inkaterra (REI), Reserva Ecologica Taricaya (RET), and Reserva Ecologica Paraıso Amazonico (REPA).	1	Land use change/deforestation (ha/year, %)	1, 2,3, 4	2
140	Bodmer et al. [97]	Pacaya-Samiria National Reserve	1	Increase in number of mammal species: 1997 (before co-management) and 2004; The per cent change in wildlife densities (%): 1996–2004	1 (state, before), 5 (co-management, after)	1
141	Ruiz-Pérez M et al. [91]	Alto Jurua Extractive Reserve (AJER), National Park of Serra do Divisor (NPSD), indigenous lands	1	Land-use change: percentage of deforestation per year (%) (Fig. 3)	1 (national park), 4 (community, trust, indigenous, extractive reserve) and a rural development project (INCRA)	3

Table 3 continued

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
142	Wallner et al. [78]	UNESCO Biosphere Entlebuch (UBE) and the Carpathian Biosphere Reserve (CBR)	2	Perceptions of locals regarding two parks (descriptive)	1, 4 (local management board)	2
143	Baral et al. [129]	Bardia National Park (BNP), Sukla Phanta Wildlife Reserve (SPWR)	2, 3	(1) Attitudes towards conservation (percentage agrees), (2) Behaviour: Frequency of resources harvested (%)	1 incl. 5 (through user groups—with two different levels of participation/functionality of user groups and different levels of NGO influence)	2
144	Norgrove et al. [86]	Mount Elgon National Park	3	"overt" and "covert" resistance to the park policies: mobilization of large groups/politicians, feigning ignorance, not turning up for meetings, letting roads become overgrown, bribing park staff and moving boundary markers under cover of darkness	1 incl. 5 (state law enforcement including participatory management)	1
145	Armenteras et al. [56]	Various in NW-AMAZON (names mostly not stated): National PAs and natural reserves, indigenous reserves, integrated-management districts	1	Fire occurrence and intensity (mean number of fires, fire radiative power per quadrant), differences in the edge effect (percentage of fires in each management type for 1 km distance bins both inside and outside the forest edge)	1 (national/state), 4 (indigenous)	3
146	Chowdhury M et al. [84]	Rema- Kalenga Wildlife Sanctuary	2, 3	(1) Attitudes towards conservation, FD and co-management project (percentage agree, scale 1–5); (2) Behaviour: changes of occupation from day-labour and NTFP collection to agriculture	1 with 5 (through Integrated Conservation and Development project)	1
147	Holland et al. [123]	Various—not stated	1	Forest cover change (%, by year)	1 (protected areas, forest reserves and patrimony forests), 2 (private/colonisation area), 4 (indigenous)	3
148	Mueller et al. [124]	Various—not stated	1	Prevention potential of 3 causes of deforestation: small agriculture, cattle ranching or mechanised agriculture (modelling, logit)	1 (national parks, integrated management), 2 (forest concessions), 4 (indigenous territories)	3
149	Nolte et al. [37]	Various—not stated	1	Gross forest cover loss: 2000–2005 (%); 2005–2010 (%); Deforestation 2001–2005 (%) and 2006–2010 (%)	1, 4, sustainable use zones	3

Table 3 continued

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
150	Oldekop et al. [43]	Sumaco Biosphere Reserve and community forests	1, 3	(1) Ecological: fern and leaf litter frog species richness; forest cover: NDVI, NIR, gap fraction; (2) Social: Establishing community reserves, monitoring and sanctions according to established rules (descriptive, scores-Table 1)	1, 4 (community forests)	3
151	Osuri et al. [105]	Sacred groves in Kodagu, Karnataka	1	Species inventory (categorical: no forest, open/disturbed, closed canopy), trends in aboveground biomass (Trends in the ratio of Landsat ETM + band 4 to band 5), changes in the extent of the sacred grove network (perception)	1 (state-managed forests), 4 (sacred groves)	3
152	Paneque-Galvez et al. [64]	Beni Biological Station with indigenous territories, forest concessions and private lands	1	Trends (ha) and annual change rates, gain, losses and swap (%) in forest cover and trends in forest fragmentation (core–edge changes)	1, 2 (concessions), 4 [indigenous territories: Tsimane and multiethnic TCO inside state-owned PA (30 %)]	3
153	Pfaff et al. [98]	Various in Acre (names not stated)	1	Deforestation trend (%, after covariate matching) in two periods separately: 2000–2004 and 2004–2008	1, 4, integrated landscape	3 and unprotected versus protected
154	Scullion et al. [125]	Various in Madre de Dios Area	1	Land-cover change (%, ha), impacts of overlapping land use policies (% reduction in the ecosystem conversion)	1, 4 and 2 (no conservation)	3
155	Vallino [55]	NA (experimental/modelled study)	1	Green patches, total biomass. Green patches = number of patches with biomass >0 at the end of the simulation divided by the total number of patches that had biomass >0 at the start of the simulation. Total biomass = sum of the biomass of each patch at the end of the simulation divided by the sum of the biomass of each patch at the start of the simulation	Other: open access, external law enforcement, internal rules	2

Table 3 continued

Study ID	Short reference	Protected area	Outcomes	Detailed outcome	Governance regime	Comparator
156	Vergara-Asenjo et al. [66]	Various in Panama	1	(Mature) forest cover change (%) and avoided deforestation over different land tenures (% of treated pixel between 1992–2008 and 2000–2008, covariate matching	1, 4 (indigenous/*comarcas*) and their combinations and overlaps totalling 6 tenure regimes): 1) legally established comarcas, no overlap with protected areas (C); (2) overlap between legally established comarcas and protected areas (C-Over); (3) claimed lands, no overlap with protected areas (Cl); (4) overlap between claimed lands and protected areas (Cl-Over); (5) nationally protected areas, no overlap with indigenous territories (PA); and (6) other lands, no protection (OL)	3
157	Vidal et al. [126]	Monarch Butterfly Reserve	1	Forest cover change/deforestation and degradation (ha) by large and small scale logging and climate related (floods, strong winds, drought, and fire)	1, 2, 4 (*ejidos*)	2

Governance regimes are coded as follows: state (=1), private (=2), NGO (=3), community (=4), co-management (=5), hybrid/other (describe). Comparators are coded as follows: governance change over time in the same PA (=1); governance compared to other governance regime in different PAs or to an other governance type within the same PA during same time period (=2), or in different forest governance regimes during same time period (3); Other (describe). Outcomes are coded as ecological (=1); attitudes (=2); behaviour (=3); spill-over (=4)

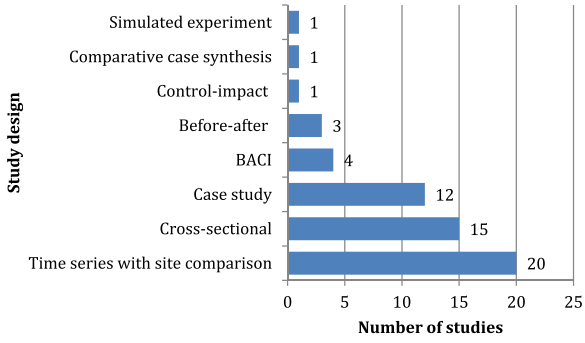

Fig. 7 Study design in included studies (N = 57)

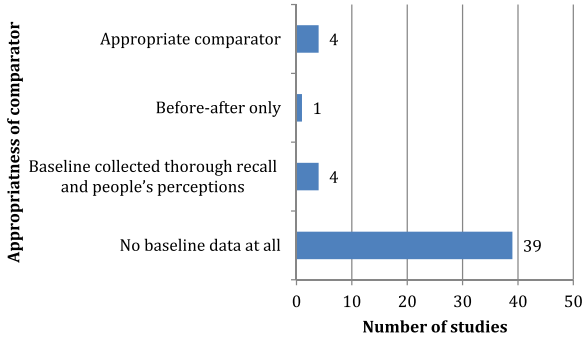

Fig. 8 Appropriateness of comparator in included quantitative and mixed-methods observational and quasi-experimental studies (N = 48)

with different levels of strictness and resource access by local communities (for example, between the core and the buffer zones), which also may have different effects on relevant outcomes. Nevertheless, we mapped only a small number of studies that could not neatly fit our four governance types because of our relatively strict inclusion criteria and generally not much information on governance in the included studies that could give us a more nuanced overview of different governance regimes. There was insufficient information on the type of actors involved in PA governance, their responsibilities, governing rules and level of power sharing to better understand the governance regime or to separately code different governance aspects (241/29.5 % studies were excluded at full-text screening stage for this reason. In some examples authors mention "governance", but they seem to refer to the management categories or the level of strictness and resource access (e.g. [98]). These examples reflect complex realities on the ground and point to difficulties in isolating and assessing conservation governance effects, but also to challenges in collating evidence with such heterogeneity and without common (governance) definitions.

Risk of evidence omission

We included studies that assess the effects of PAs relative to community or private concessions. However, we might have failed to include studies that focus on the community or private forestry, but had PAs as a comparator. This might have happened at the initial levels of evidence screening (at title and abstract) as the comparator is typically less explicit in the title or abstract. Consultation with the stakeholders and experts during the systematic review conduct can help to mitigate this bias. Moreover, some important evidence might have been missed through the exclusion of the non-English literature (using English search terms only we found and excluded 20 studies for this reason). Accuracy of the map (and of potential evidence synthesis) could have been higher with this type of evidence.

Limitations in the evidence base on the governance role and impacts in conservation effectiveness

Acknowledging and reporting the role of governance

The majority of screened full-text articles (93 %) did not have all the necessary pieces of evidence to be included in the map. It was not possible to code in detail different governance regimes and map information on nature of participation, level of decentralization, number of actors and their responsibilities, which would allow for testing our hypotheses from the Protocol (see [11]). There are two reasons for this. Studies that described institution and governance regimes in detail were lacking sufficient details on relevant outcomes and were rejected (e.g. [102]) (175 or 21.4 % studies were excluded with this reason). These kinds of studies frequently focus on intermediate variables such as level of participation, but without robust measures of conservation policy outcomes which is also noted in the literature on decentralization in forestry (see: [103]). In other cases, when research entailed relevant outcomes (e.g. forest cover change or biodiversity assessment), there was no (or insufficient) information on the governance regimes. However, the studies lacking information on governance might not be aiming, and were possibly not designed, to evaluate the role of the governance in conservation effectiveness.

Identified studies mostly include state and community (including both informal and formal) forests and PAs, but they focus less on the private and co-managed forests and PAs (Fig. 5). We also included four studies measuring informal forest PAs effectiveness (e.g. sacred groves) [71, 73, 104, 105]. Although they might not fit into the PA definition as state governments rarely recognize them, there is potential in learning from the case of persistence or deterioration of informal and traditional institutions (governed through taboos or religious beliefs) in protecting the forest resources [106]. This is especially relevant

in situations where informal external rules are not easily enforced [107]. Nevertheless, very frequently such studies provide botanical inventories of sacred groves only, and are not designed with the appropriate comparator to show the comparative value of such conservation regimes and in such cases they could not be included in this map.

Reported outcome types

The majority of identified studies focused on only one, specifically ecological, type of outcome (e.g. land cover change studies that focus on deforestation rate only). Nevertheless, conclusions of these kinds of studies on PA effectiveness can give an incomplete or biased picture as PAs are deeply embedded in social, economic and political spheres of the society as well [108]. Moreover, we could not identify relevant studies that address spill-over effects or policy side effect while comparing two or more PA governance regimes. This might be because our definition of the spill-over outcome was too vague. Moreover, measurement of spill-over effects requires baseline data which are frequently missing or hard to obtain in the PA-related research as a majority of conservation interventions were never designed to be evaluated [109]. Nevertheless, studies that measure spill-over effects would be beneficial for a comprehensive understanding of the conservation governance effects on wider scales.

Study designs, comparator and attribution problem

Frequently, studies have information on outcomes and governance, but lack comparison against which a specific governance regime can be evaluated (144/17.6 % studies were excluded at the full text stage with this reason). The majority of included studies (52.6 %) compare PAs to adjacent forests outside of PAs, but this cannot tell us anything about the relative effectiveness of different PA governance regimes (although given sufficient evidence, meta-analysis of this data could provide some answers). Attribution, or isolating and accurately estimating the effect of intervention and assuring the flow of causality from the intervention to the outcome, is one of the central questions in the evaluation [110]. Nevertheless, not many identified studies were designed to allow for attribution of the effect to the intervention. The majority of the included studies lack baseline data. Similar to observations in other relevant reviews [42, 46] in this map only a small number of included studies had a BACI design (=4) or used statistical matching (=3) to create a reliable comparator, control for spatial and time-variant bias and attribute actual outcomes to the intervention and not to some other modifiers. Time-series or spatial comparison designs can attribute effects to the intervention only if there are no other factors explaining the change in effects or when only the intervention influences ground conditions, which in complex a conservation scenario is almost impossible. Moreover, studies rarely exclude alternative scenarios that might have influenced measured outcomes, or do not use qualitative data to build and support causal reasoning and make theories of change [38]. Counterfactual thinking or "*what would have happened if there had been no intervention?*" is crucial for answering effectiveness questions and is yet to be mainstreamed in conservation programme and policy evaluations [38, 39, 109, 111, 112].

Geographical spread of research

This map, with its specific inclusion criteria, has not captured research located in the northern parts of North America (USA and Canada), in Australia, and in north and west Asia. Europe and Africa are covered with this map, but only to a small extent. There could be several plausible reasons for this limited geographical spread of mapped studies (e.g. lack of information on governance in studies connected to some research locations, or lack of relevant outcomes and comparator in the other locations), but given the scope of this map, we have not looked into the details of this aspect.

Conclusions

The presented results call attention to the research gaps in the field of conservation governance, provide methodological guidelines and generate specific questions for future primary research. However, with the present work we are unable to provide more detailed explanations of links between the governance and conservation outcomes, as we were only able to map the literature on the topic, and no data extraction and evidence synthesis were undertaken.

Implications for practice and policy

Here we give an overview of the state of the evidence base in terms of the quantity and quality of studies captured in the review. As in other examples of systematic reviews in conservation [42] and decentralization and community forest management [113, 114], the evidence base in this map is limited, in the sense of size, quality and geographical spread. Most of the studies do not exclude alternative explanations or control for non-random assignment of conservation interventions. Instead, they apply simple site comparisons or use time-series when comparing different governance regimes, do not control for selection bias, and very rarely use regression or matching methods. Recent calls for more rigid evaluations of conservation interventions and methodological advances supported by procedures and methods of impact evaluation [38] should help to strengthen the evidence base on the

impact of governance in the conservation effectiveness of forest PAs.

Implications for research

If the evidence base was not as limited, the research question of this map could have been broken down into smaller parts and several systematic reviews could have been undertaken. Each governance regime could have been assessed separately to better understand the magnitude and the direction of the effects of one specific governance regime over the other in PAs (or in comparison with community forests). When conducting evidence synthesis on conservation governance, reviewers need to be careful when extracting and synthesizing data from different counterfactual scenarios. Namely, one cannot compare outcomes obtained from a comparison between state PA and community forests with comparisons between state PAs and no intervention. These are two different counterfactual conditions and if not clearly separated, these comparisons would give a wrong picture of intervention effects to policy makers. Reviewers have to acknowledge complexity, develop common broader definitions, provide context through qualitative data and policy documents, develop theories underpinning complex governance interventions and be transparent at all stages of the review (especially about the lack of consensus) in order to capture evidence. Lessons can be learned from attempts to provide guidance on evidence synthesis of complex interventions in medicine [115]. With the current methodological developments in the realm of qualitative and quantitative conservation impact evaluation, the evidence base would probably improve and this map should be updated with any new evidence before any future synthesis is undertaken.

Based on our observations of the methodological rigour of current research, we provide the following summary of the shortcomings of the current evidence base in terms of knowledge gaps and the need for primary research.

While conducting analysis of conservation intervention effects in complex social-ecological systems such as PAs, research has to take into account local context and governance variables that might modify the effects of the intervention. Therefore, it is necessary to have more PA effectiveness studies with more detailed governance information, specifically how and by whom are decisions made and implanted, the role of different actors in the decision making and their responsibilities and accountability. The role of governance in PAs effectiveness should be assessed relative to local dynamics (see [116]) and researchers have to develop in-depth understanding of institutional, contextual and historical diversity to be able to conduct more rigorous analysis and decompose governance processes into elements that can be more easily analysed (see for example nested multi-tiered diagnostic approach for analysis of outcomes in social-ecological systems [47, 48]). Large-n comparative studies that can show lessons from different countries and continents within similar (economical, ecological or social) contexts, including sufficiently detailed information on local governance, institutions and actors, are necessary. As already mentioned, rich data on institutional, contextual and historical diversity comes from the qualitative research and case studies, but this work has not qualified for inclusion in this map due to lack of relevant outcomes or a comparator. Small and localised studies on governance processes that include rigorous measures of outcomes are thus needed to fill the evidence gaps. Therefore, we see a need for the methodological pluralism to obtain knowledge and improve understanding of the complex systems such as forest PAs and interactions of its sub-components such as governance and resource systems ([47, 117]). Interdisciplinary research teams that can capture the complexity of forest PAs, simultaneously looking at institutional setting as well as social and ecological outcomes of PAs would be needed. Forestry Resources and Institutions (IFRI) methodology and research (http://www.umich.edu/~ifri) is a good example of this point. Incorporating measures of both social and ecological outcomes will give a more nuanced and complete picture of different PA effects, also acknowledging synergies and trade-offs in conservation [118]. Similar to Bowler and colleagues [113] in their review on community forest management, we also recommend standard outcome measures of conservation success to be able to compare between the studies. Moreover, study designs that allow for attribution and causality; include baseline data; have appropriate choice of comparator and exclude alternative scenarios have to be prioritized to isolate effects of governance regimes in the complex ground realities. This is especially applicable for land use change studies where satellite images only cannot tell the story of the PA effects without in-depth studies of local institutions as well as national political context. If this is not possible, researchers have to understand and acknowledge these limitations. Moreover, funding agencies perhaps have to understand the value of the baseline data collection that will allow researchers to conduct better evaluations of the conservation interventions. Higher level of methodological details and more details in the reporting of the methods and results is needed to enable appraisal of the research reliability. Longer-term studies with good baselines are needed to understand the impacts. More evidence is needed on the conservation impacts of private or co-managed PAs in comparison to other PA governance types. Research on spill-over

effects of forest PAs conditional on their governance type is necessary. Based on these observations, we identified some of the research questions to fill in current research gaps: (1) What are the effects of private protected areas on social and ecological outcomes when compared to other types of protected areas? (2) What are the effects of co-managed protected areas on social and ecological outcomes when compared to other types of protected areas? (3) Which governance regimes (state, private, community or co-managed) might cause a comparatively higher spill-over effects in the context of forest protected areas? Based on the current trends in the literature and methodological developments in the conservation policy analysis, we expect more robust studies on conservation effectiveness and higher attention to the (impact of) different governance regimes on conservation outcomes.

Additional files

Additional file 1. Scoping exercise, search string development and finalized search string in Web of Science.

Additional file 2. Database search and differences in search strings according to DB search facility.

Additional file 3. Search through specialist search.

Additional file 4. Bibliographic search.

Additional file 5. Search through web search engine.

Additional file 6. List of unobtainable studies.

Additional file 7. List of excluded studies with reasons for exclusion.

Additional file 8. Coding tool with code definitions and rationale for coding, including critical appraisal codes and scoring system.

Additional file 9. Systematic map database.

Authors' contributions

BM undertook all mapping activities and wrote the manuscript. LS and ASP contributed to the analysis, interpretation, synthesis and writing. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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